



Faculty of Manufacturing Engineering

**DEVELOPMENT OF MAN TO MACHINE (M2M) RATIO
TECHNIQUE IN SEMICONDUCTOR COMPANY**

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**DEVELOPMENT OF MAN TO MACHINE (M2M) RATIO TECHNIQUE IN
SEMICONDUCTOR COMPANY**

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ABSTRACT

Tough global competition requires every manufacturer to be more creative on ways to reduce every aspect of their operational cost. To remain competitive, manufacturers need to shorten the cycle time in New Product Introduction to capture the market share, reduce manufacturing cost and explore ingenious ways to improve productivity. Labor cost is among the key cost contributors that the manufacturers are focusing on and lean manufacturing is among the strategy taken by many companies to improve their competitive advantage.

Labor productivity improvement is all about getting more units out with the same or lesser amount of labor. Before determining the ideal number of people required for the operation, a proper method of defining the current utilization of the labor working on the equipment in the production line is required. Once the current labor utilization is known, only then the ideal utilization of the operator can be accurately determined and recommendations for productivity improvements can be made. Hence, the purpose of this research is to develop a suitable work study technique to measure the labor productivity at the semi-auto back-end semiconductor manufacturing line.

This thesis aims to discuss the development of a work study technique called the Man to Machine Ratio (M2M) to determine the present manning utilization and propose ideal man to machine ratio of the back end semiconductor manufacturing processes. M2M

technique was derived through the determination of the key factors from the established method of Process Mapping and Multi Machine Chart. In addition, MOST Predetermined Time Standard was used as the method to perform work measurement. To assist in the measurement stage, the M2M template was designed using Microsoft Excel Spreadsheet. Next, five case studies utilizing the Lean Six Sigma DMAIC project management approach were carried out to test the suitability of the M2M method at the back end semiconductor manufacturing line based on a set of key criteria. The case study results showed that the M2M method was able to determine labor utilization and man to machine ratio, provide accurate data and have the flexibility to be used at both manufacturing and non manufacturing processes. Moreover, M2M is easy to develop, maintain and communicate and does not require a high skill set. By employing the M2M method together with DMAIC systematic approach, focus area for productivity improvement could be identified and the back end semiconductor company will be on the right track towards achieving a leaner operation.

ABSTRAK

Persaingan hebat di peringkat global memerlukan setiap industri menjadi lebih kreatif dalam mencari jalan mengurangkan setiap aspek kos operasi mereka. Untuk kekal kompetitif, industri hendaklah mengurangkan masa dari peringkat pengenalan kepada produk, kos operasi dan mencari cara-cara untuk meningkatkan produktiviti. Kos pekerja adalah di antara penyumbang utama kos operasi sesebuah organisasi dan 'lean manufacturing' adalah antara strategi yang telah diambil untuk meningkat daya saing.

Tujuan meningkatkan produktiviti pekerja adalah terutamanya untuk mendapatkan lebih pengeluaran unit menggunakan kuantiti pekerja yang sama atau yang kurang dari sebelumnya. Sebelum kuantiti pekerja yang sebenar diperlukan dapat ditentukan, teknik yang betul perlu untuk menentukan tahap penggunaan setiap pekerja tersebut sekarang. Setelah tahap penggunaan setiap pekerja sekarang telah ditentukan, barulah cara-cara untuk meningkatkan produktiviti mereka dapat dikenalpasti. Oleh itu, tujuan kajian ini dijalankan adalah untuk merangka satu teknik yang sesuai untuk digunapakai bagi mengukur produktiviti pekerja yang bekerja di bahagian hiliran pengeluaran produk separa-konduktor.

Kajian ini juga akan membincangkan bagaimana teknik Nisbah Pekerja kepada Mesin (M2M) dirangka untuk menentukan tahap penggunaan pekerja sekarang dan tahap penggunaan pekerja yang benar-benar diperlukan oleh pihak pengurusan. M2M diterbitkan

menggunakan elemen-elemen penting dari teknik sedia ada iaitu Pemetaan Proses and Carta Berbilang Mesin. Untuk mengukur masa, MOST ataupun teknik penentu masa piawai telah digunakan. Untuk memudahkan proses pengambilan data, borang M2M telah dirangka menggunakan perisian Microsoft Excel. M2M kemudiannya telah diuji menggunakan lima kajian kes menggunakan pendekatan 'Lean Six Sigma DMAIC' untuk mengukur sejauh mana kesesuaian M2M untuk diaplikasikan di bahagian hiliran pengeluaran produk separa-konduktor. Keputusan menunjukkan bahawa M2M dapat membantu menentukan tahap penggunaan pekerja sekarang dan mencadangkan nisbah pekerja dan mesin yang sesuai yang lebih tepat. M2M juga boleh diguna untuk pelbagai proses termasuk kerja-kerja yang tidak berkaitan dengan mesin. Tambahan lagi, M2M mudah digunakan, diurus dan diterangkan serta tidak memerlukan kepakaran yang tinggi. Dengan menggunakan teknik M2M dan DMAIC secara sistematik, organisasi dapat memfokuskan kepada aktiviti-aktiviti yang mampu membantu mencapai tahap kecekapan pekerja yang lebih optimum.

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A journey is easier when you travel together. Interdependence is certainly more valuable than independence. This thesis is not the result of the work of an individual person but accompanied by the support of many people. It is a pleasant aspect that I have now the opportunity to express my gratitude to all of them.

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Finally, I would like to thank all whose direct and indirect support helped me to persevere throughout the duration of this thesis.

DECLARATION

I declare that this thesis entitle ‘ Development of Man to Machine (M2M) Ratio Technique in Semiconductor Company’ is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : ROHANA BINI ABDULLAH
Date : 3 FEB 2010

DEDICATION

To my beloved parents, husband and children

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CHAPTER ONE

INTRODUCTION

1.1 Background

With so many players in the semiconductor business, it is critical for each of them to reduce the operating cost and improve the profit margin. Performance metrics are used to measure a company's success. Among the important and commonly used performance metrics are on-time delivery, quality, productivity, resource utilization, inventory turn-over and customer incidents (Engle, 2005). In order to retain the current customers or attract new customers, companies are more attentive to the customer requirements and more driven towards improving their manufacturing flexibility and productivity (Phillips, 2000).

Traditionally, the focus on productivity improvement was mainly on how to increase the utilization of the capital. But slowly, companies are adopting lean culture where the drive is to eliminate waste everywhere in the organization. Lean is a process improvement methodology originating from the Toyota Production System in the 1960s. Waste in Lean is defined as anything other than the minimum amount of equipment, materials, parts, space and worker's time, which are absolutely essential to add value to the products or services (Canel *et al.*, 2000). Therefore, the elimination of waste is not only

focused on the equipment, process and materials. Due to the rising labor cost factor, labor is now becoming more valuable asset to an organization and has a big opportunity to be improved. In Lean Manufacturing, labor contributes to the motion, waiting and overproduction types of waste (Rawabdeh, 2005). Coleman *et al.*, (2004) also recognized that productive human capital is one of the major contributors to a company's success.

Companies that are systematic and continuous in their effort to eliminate waste will enhance their competitiveness in the market due to the increased in efficiency and improved productivity. These companies will reap the benefits in terms of lower raw stock material, reduced work-in-process, low finished goods inventories, high level of product quality, increased flexibility and ability to meet customer demands. All these will result in lower overall manufacturing costs and increased employees involvement (Canel *et al.*, 2000).

The importance of focusing on the labor productivity has long ago been recognized by the pioneers in Industrial Engineering such as Frederick W.Taylor, Frank Gilbreth and his wife Lilian Gilbreth. They have dedicated their lives to study various types of techniques, methodologies and productivity strategies. These works have become the basis of this research where the traditional methods will be studied together with the modern techniques developed more recently utilizing simple Microsoft office tools, mathematical formulas and advanced computer simulations software. The factors used in the existing work study techniques are the key to achieve the objective to develop the Man to Machine (M2M) ratio technique in the effort to identify a suitable work study tool for the measurement of labor utilization and man to machine ratio study at the back end semiconductor manufacturing.

1.2 Problem Statement

An established semiconductor company located in Senawang Industrial Area, Negeri Sembilan was faced with high labor turn over due to competitions with other emerging companies in the same area. The company policy did not allow for hiring of foreign worker to work as the manufacturing operator thus making the hiring process more difficult since the potential candidates often will select company that was able to offer better salary and more conducive working environment. The existing practice to hire manufacturing operator was by the manufacturing supervisors determining the number of operators required and the management has no method to check whether this quantity was higher than the actual requirement or not. Therefore, the company wanted to find an accurate way to determine the actual number of operators required especially for the critical processes. In addition, the management also wanted to focus on identifying opportunities to reduce or eliminate waste in the production line and improve labor productivity.

1.3 Research Objectives

This study will focus on developing method to measure and improve the labor utilization for the back-end semiconductor manufacturing facility. Due to the demand for a simple and accurate method to be used in the semiconductor manufacturing environment, this research aims to utilize the Industrial Engineering (IE) skills to develop an innovative work study method called Man to Machine (M2M) ratio and evaluate this method in the semi automatic back end semiconductor manufacturing line.

This research will also answer these research questions:

- i. What techniques have been used to study labor utilization and man to machine ratio?

- ii. What are the contributing factors observed to determine the utilization of labor and man to machine ratio from all these existing techniques?
- iii. How M2M technique is developed based on the factors identified from the existing techniques?
- iv. Can M2M technique be applied at the back-end semiconductor manufacturing environment?

Therefore, the objectives of the research are to:

- i. Identify the important elements from the existing work study technique that can be utilized in the development of the Man to Machine (M2M) ratio technique.
- ii. Develop the Man to Machine (M2M) ratio technique based on the key elements identified.
- iii. Design work study template to assist the implementation of M2M ratio technique at back-end semiconductor production line.
- iv. Test the suitability of the new technique at the back-end semiconductor production line in achieving productivity improvement.

1.4 Scope of Work

The research will start by reviewing the different work study techniques being utilized and the key factors to determine labor utilization and labor productivity.

In search for a suitable method to be applied at the semi automatic back-end semiconductor manufacturing process, selected existing work study techniques will be

evaluated based on a pre-determined set of criteria. In addition, the scope of work will also include identifying the common elements being used to calculate the operator's utilization and the man to machine ratio. Once the common elements are identified, a method to determine labor utilization and man to machine ratio at the back end semiconductor called Man to Machine Ratio Technique (M2M) can be designed. To test the suitability and effectiveness of this M2M technique, case studies will be performed at the back end semi-automatic semiconductor manufacturing processes of a selected multinational semiconductor manufacturing facility utilizing a systematic Six Sigma project management approach.

1.5 Research Significance

Grunberg (2003) mentioned that the key to any given investigation is to select the most appropriate method for the study based on the identified set of key factors to be improved. Therefore, the new method is aimed to be an alternative tool for the work and measurement study if the cost, speed, skill set, accuracy and flexibility are among the factors that a company is looking for. In addition, although the scope of the study is to find a suitable tool for the back-end semiconductor environment, the value of the new method is hoped to benefit other industries be it the international or the small and medium enterprises (SMEs).

This tool can be used as an alternative to the big companies although normally these companies have the money to purchase expensive tools and hire highly paid engineer or consultant to perform labor productivity study for them. On the contrary, the SMEs do not have the big cash to spend on productivity measurement tools and therefore, the new method is intended to be able to provide them with low cost but accurate method to measure and have an optimized workforce.

In company's pursuit of achieving Lean, the new technique will also be able to be used to identify wastes before productivity improvement activities can be performed.

1.6 Organization of the Report

Overall, the structure of the report is organized into seven chapters namely (i) Introduction (ii) Literature Review (iii) Research Methodology (iv) M2M Technique Development (v) Case Studies (vi) Result and Discussion (vii) Conclusion. Figure 1.1 illustrates a guided flow of information within the structure of the report.

Chapter one outlines the background of the overall research which encompasses the importance for companies to reduce the operating cost and improve their labor productivity in order to remain competitive in the global market. Furthermore, the problem will be stated and the scope of work will be determined. The significance of the research will also be discussed in this section.

Chapter two explains the concept of productivity, the various issues pertaining productivity including the relationships between lean and productivity. This chapter also gives the overview of the many types of Lean tools and techniques being used for the purpose of improving the productivity for a company and the importance of Work Study techniques in the lean implementation. In addition, the review will also include Six Sigma project management methodology as a powerful tool to be used to complement Lean Manufacturing projects.

Chapter three focuses on the research methodology adopted in this research. The intent of this chapter is to explain how this research attempts to achieve the objectives of this research through the identification of the important elements for determining labor productivity in the present Work Study techniques, the development of the M2M technique and the design of the M2M template. In addition, case studies will also be conducted